

Technical Airworthiness Authority Advisory (TAA Advisory)	
Title	Integrity Monitoring Requirements for Aircraft Electrical Wiring Interconnection Systems (EWIS)
Advisory Number	2018-01-v2
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Reference	TAM, PART 3, CHAPTER 4, ANNEX D
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1 Purpose

- 1.1 This Technical Airworthiness Authority (TAA) Advisory provides clarification and guidance on how to meet Department of National Defence (DND) requirements for aircraft Electrical Wiring Interconnection System (EWIS) integrity monitoring.

2 Applicability

- 2.1 This TAA Advisory is applicable to all DND-owned fixed and rotary wing aircraft. For Unmanned Aircraft Systems and Leased Aircraft, TAA Guidance must be sought to determine if this advisory is applicable.

3 Related Material

3.1 Definitions

- a. Enhanced Zonal Analysis Procedure (EZAP). A logical process for developing maintenance and inspection instructions for EWIS.

3.2 Regulatory References

- a. Transport Canada Civil Aviation (TCCA) TP 14331E – *Enhanced Zonal Analysis Procedures*, 30 September 2005 (Program to Enhance Aircraft Electrical Wiring Interconnection System Maintenance) (available internally, within DND, at AEPM RDIMS #1614460)
- b. DND *Flight Safety Investigation Report – CC130342*, 21 February 2012 (available internally, within DND, at AEPM RDIMS #1619676)
- c. Federal Aviation Administration (FAA) *EWIS Job-Aid 2.0* (available internally, within DND, at AEPM RDIMS #1614636)
- d. FAA *EWIS Speakers' Notes* (available internally, within DND, at AEPM RDIMS #1614637)
- e. C-05-005-001/AG-001 – *Technical Airworthiness Manual (TAM)*
- f. C-05-005-P12/AM-001 – *Engineering Process Manual (EPM)*
- g. FAA AC25-27A – *Development of Transport Category Airplane Electrical Wiring Interconnection Systems Instructions for Continued Airworthiness Using and Enhanced Zonal Analysis Procedure* (available internally, within DND, at AEPM RDIMS #1614618)
- h. AF9000+ procedure EMT05.006 – *Monitoring of Airworthiness and Aviation Safety Documents (AASD) within WSM Organizations*

4 Discussion

- 4.1 Over the years, there have been a number of in-flight smoke and fire events where contamination sustained and caused the fire to spread. TCCA and the Canadian Transportation Safety Board (TSB), together with the FAA, the U.S. National Transportation Safety Board (NTSB) and the Joint Aviation Authorities (JAA) have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft drinks and napkins. In some cases, dust has been found completely covering wire bundles and the surrounding area.
- 4.2 Research has also demonstrated that wiring can be harmed by collateral damage when maintenance is being performed on other aircraft systems. For example, a person performing an inspection of an electrical power center or avionics compartment may inadvertently cause damage to wiring in an adjacent area.
- 4.3 In recent years, the regulatory authorities and industry groups have come to the realization that current maintenance practices may not be adequate to address aging non-structural systems. While age is not the sole cause of wire degradation, the probability that inadequate maintenance, contamination, improper repair, or mechanical damage causing degradation to a particular Electrical Wiring Interconnection System (EWIS) increases over time. Studies by industry and government agency working groups have found that, although EWIS management is an important safety issue, there has been a tendency to be complacent about EWIS (see paragraph 5 – *Related Reading Material* – within reference 3.2.a.). These working groups have concluded that there is a need to manage EWIS, so that they continue to function safely.
- 4.4 To address the effects of aging on EWIS, a recommendation on best maintenance practices was created to mitigate the effects of aging on electrical and wiring systems. As indicated by the acronym, it was based on a new maintenance philosophy that wire and its associated systems must be viewed as a complete system and not simply a means of connecting other independent systems. All aircraft are filled with miles of wiring and hundreds of wiring devices that connect and transfer power and signals to and from electrical components. Virtually all aircraft systems rely heavily on some type of wiring for safe operation. The health and integrity of the EWIS can be significantly compromised due to deterioration from aging, compounded maintenance, damage and the failure of wiring installation. It is integral to the overall maintenance and sustainment of all aircraft that the EWIS be treated as a system and afforded the same level of importance as the aircraft structure and other critical flight control systems.
- 4.5 In February 2012, a CC130342 experienced an on-board fire, resulting in a Category A occurrence, due to routing and clamping deficiencies in a modification made to install ground test connections to the auxiliary hydraulic system. Chafing between the hydraulic pump motor power wire and a pressurized hydraulic flexible hose caused electrical arcing between the wire and the hose, which resulted in a pin-hole breach of the flexible hose, release of hydraulic fluid under high pressure, and initiation of the fire. This incident highlights the importance of ensuring EWIS best practices are applied during design and maintenance. The flight safety report for this accident can be found at regulatory reference 3.2.b.
- 4.6 Regulatory references 3.2.c. and 3.2.d. provide an excellent overview of EWIS.

5 Action/Method of Compliance

- 5.1 **Requirement Text.** The para 2 text contained in the TAM Annex D of Part 3, Chapter 4, Section 2 – EWIS Integrity Monitoring Requirement – reads as follows:

“2. Definition. *As used in this annex, Aircraft Electrical Wiring Interconnection System (EWIS) means any wire, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points. This includes:*

- a. *wires and cables;*
- b. *bus bars;*

- c. *the termination point on electrical devices, including those on relays, interrupters, switches, contactors, terminal blocks and circuit breakers, and other circuit protection devices;*
- d. *connectors, including feed-through connectors;*
- e. *connector accessories;*
- f. *electrical grounding and bonding devices and their associated connections;*
- g. *electrical splices;*
- h. *materials used to provide additional protection for wires, including wire insulation, wire sleeving, and conduits that have electrical termination for the purpose of bonding;*
- i. *shields or braids;*
- j. *clamps and other devices used to route and support the wire bundle;*
- k. *cable tie devices;*
- l. *labels or other means of identification;*
- m. *pressure seals;*
- n. *fiber optics;*
- o. *EWIS components inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks, including, but not limited to, circuit board back-planes, wire integration units, aircraft stores and associated suspension equipment and external wiring of equipment.*

ADVISORY NOTE

EWIS does not include components inside, and the external connectors that are part of, the following:

- a. *electrical or avionic equipment (Weapon Replaceable Assembly (WRA)) installed in an aircraft rack or shelf; and*
- b. *portable electrical devices that are not part of the type design of the airplane, such as personal entertainment devices and laptop computers.”*

5.2 **Guidance.** The EWIS components listed in para 2 of the requirement are the only EWIS components mandated to be monitored under Annex D of Part 3, Chapter 4, Section 2 of reference 3.2.e.

5.3 **Requirement Text.** The para 3 text contained in TAM Annex D of Part 3, Chapter 4, Section 2 – EWIS Integrity Monitoring Requirement – reads as follows:

“3. EWIS Monitoring Program. *An EWIS monitoring program shall be implemented for every aircraft type on the DND register. This program will include, without being limited to, the following components:*

- a. *Evaluation of the inspection schedule, to ensure that the EWIS inspection program has sufficient coverage of the potential EWIS hazards. This evaluation should ensure:*
 - (1) *identification of EWIS within the inspection schedule;*
 - (2) *appropriate inspection tasks for EWIS, where a system failure will cause a significant hazard to the aircraft resulting from close proximity to:*
 - (a) *combustible materials;*
 - (b) *primary and back-up hydraulic systems; and*

(c) *mechanical or electrical flight controls;*

(3) *sufficient inspection tasks to evaluate EWIS condition for wear, wire bundle separation, cleanliness and proximity to physical objects, such as aircraft structure, rigid lines and Weapon Replaceable Assemblies (WRAs)."*

5.4 **Guidance.**

5.4.1 Evaluate the aircraft type using the Enhanced Zonal Analysis Procedure (EZAP), as detailed in reference 3.2.a. Further guidance is available at reference 3.2.g.

5.4.2 The currently approved maintenance program should be changed to incorporate the output from the EZAP assessment using the fleet approved EWIS maintenance manual as acceptable inspection criteria.

5.4.3 Any design change adding or modifying EWIS should include an assessment, as detailed in Appendix C of reference 3.2.a, to determine whether the modification has affected the zone EWIS attributes to warrant reapplication of the EZAP to the entire zone. Further guidance is available at Appendix B of reference 3.2.g.

5.4.4 The DTAES electrical Subject-Matter Experts can be consulted to provide advice and assistance in performing the EZAP fleet assessment and to incorporating the appropriate inspections per the EZAP results.

5.5 **Requirement Text.** The para 3.b. text contained in the TAM Annex D of Part 3, Chapter 4, Section 2 – EWIS Integrity Monitoring Requirement – reads as follows:

“3. [...]

b. *Evaluation through reliability and maintainability analysis of the effectiveness of the aircraft maintenance schedule tasks assigned to EWIS. This evaluation shall include reviews of both corrective and preventive maintenance findings that relate to EWIS failures.”*

5.6 **Guidance.** Once the EWIS monitoring program requirements, per para 5.3 and para 5.4, have been incorporated in the fleet’s In-Service Monitoring Program (ISMP), the TCH should ensure the effectiveness of their EWIS monitoring program using their existing ISMP activities.

5.7 **Requirement Text.** The para 3.c. text contained in the TAM Annex D of Part 3, Chapter 4, Section 2 – EWIS Integrity Monitoring Requirement – reads as follows:

“3. [...]

c. *Management of the aircraft Electrical Loads Analysis established during type certification, to ensure that EWIS design changes do not exceed load capacity of individual aircraft electrical systems or total capacity of the electrical generating system.”*

5.8 **Guidance.** The TCH will review and amend, as required, their master Electrical Loads Analysis (ELA) to verify that it reflects the current aircraft configuration. They should also create, if not already established, a process to ensure any modifications to the ELA are implemented in the master ELA.

5.9 **Requirement Text.** The para 4 text contained in the TAM Annex D of Part 3, Chapter 4, Section 2 – EWIS Integrity Monitoring Requirement – reads as follows:

“4. Corrective Action. *Where the aircraft EWIS integrity monitoring activities have identified a possible reduction in the level of aircraft safety, corrective action shall be taken in accordance with the requirements of 3.4.2.S1.2. Additional considerations for corrective action shall include:*

a. *changes to maintenance schedule task frequency or task instructions; and*

- b. *changes to corrective maintenance instructions to enhance coverage of protection and caution information that will minimize contamination and accidental damage to EWIS, as applicable, during performance of maintenance or repairs.”*

5.10 **Guidance.**

5.10.1 When EWIS in-service monitoring activities identify a possible reduction in safety, the use of a process (e.g., reference 3.2.h, or another process deemed to be equivalent by the TAA) to assess the data should include the following components:

- a. Review and Evaluation of the in-service difficulty;
- b. A Root cause analysis of the in-service difficulty; and
- c. A follow-up action plan to address the in-service difficulty.

5.10.2 As per para 3.4.2.S1.2 of reference 3.2.e, the follow-up action plan to address the root cause can include:

- a. Adjustments to usage or role;
- b. Design change or product improvement; and
- c. Maintenance program amendments.

5.10.3 If the follow-up action is related to a design change or a change to the maintenance program, the maintenance instructions will be reviewed to ensure the aircraft's Approved Maintenance Program contains the appropriate protection and caution recommendations, based on industry best practices, contained in reference 3.2.a. The TAA expects that the TCH will identify protections and caution information in a manner or form that conveys the information to the technician. For example, for a change to the maintenance program, or a Special Inspection (SI), which potentially requires maintenance that affects EWIS, the TCH could use this cautionary statement:

“Keep the work area, wires, and electrical bundles clean of metal particles or contamination when you use tools. Unwanted material, metal particles, or contamination caught in wire bundles can cause damage to the bundles. Damaged wire bundles can cause sparks or other electrical damage.”

5.10.4 The Record of Airworthiness Risk Management (RARM) process should be initiated when the follow-up actions cannot be implemented immediately and the delay in implementation results in an unacceptable level of safety for the aeronautical product, in accordance with TAM paragraph 3.4.2.S1.3.

5.11 **Requirement Text.** The para 5 text contained in the TAM Annex D of Part 3, Chapter 4, Section 2 – EWIS Integrity Monitoring Requirement – reads as follows:

*“5. **Reporting.** The Electrical Wiring Interconnection System Monitoring Program shall be reviewed at least every two (2) years, with the end of the review schedule such that the review data and results are available for presentation to the Airworthiness Review Board (ARB) for that particular year. Reporting will include results of data collected as per items listed in paragraphs 3 and 4 above.”*

5.12 **Guidance Text.** The Technical Section of the Annual Airworthiness Report (AAR) should include the status of the program since the last reporting period.